Design and Fabrication of Multi-Function Controlling IC for Full Resolution Stereo Display

Jian-Chiun Liou*[1]

Electronics and Optoelectronics Research Laboratories, Industrial Technology Research Institute (EOL/ITRI), Rm.936, Bldg.51, No.195, Sec.4, Chung Hsing Rd., Chutung, Hsinchu, 31040, Taiwan, R.O.C.

*[1]jcliou@itri.org.tw

Abstract

In this paper, I propose a new type of multi-function controlling integrated circuit (IC) for full resolution time sequential 3D display with light-emitting diode (LED) strobe backlight signal processing and optical shutter glasses. Each shutter is synchronized to block the unwanted image and transmit the wanted image. 120Hz liquid-crystal display (LCD) and an LED dynamic backlight are used to implement a multi-viewer time multiplexed 3D display. The scanning or the strobe of the dynamic LED backlight is driven by the same vertical synchronization signal. Testing results of the proposed dynamic backlight are presented and compared with results obtained by the traditional backlight type.

Keywords

Controlling IC; 3D Signal Processing; Dynamic Backlight; Time Multiplexed; ASIC

Introduction

Thus special glasses based stereoscopic displays are still popular [1-10]. Among various stereoscopic 3D vision displays, owing to the resolution and viewing angle characteristics, the image performance of a time multiplexed 3D display is usually better than a spatial multiplexed 3D display.

While implementing this time multiplexed stereoscopic display, the left-eye image and the right-eye image should be displayed by page-flipping mode. That is, in about one sixtieth second, a pair of left-eye and right-eye images should be shown consecutively to the viewer. While the left-eye image is shown in the first half of one sixtieth second, line of vision (mean that sight) to the display of the viewer's right eye should be blocked by the liquid crystal (LC) shutter [11-16]; while the right-eye image is shown in the second half of the one sixtieth second, the viewer's left eye should be blocked. In this way, the viewer's left eye can see only the left-eye image in every first half of the sixtieth second, and his right eye sees only the right-eye image. That is, the viewer is able to see a series of stereoscopic image pairs by an image rate of 60Hz. At this image refresh rate higher than 50 Hertz for each eye (60 Hertz is better), the viewer will not feel image flicker. A flickering effect may be observed because a user is able to notice a frequency lower than 50 Hz. Accordingly, the backlight driver may drive the light sources at a frequency of approximately 120 Hz, synchronized with that of the image signal, so the user is not able to perceive the flickering effect and flicker can be reduced. Using cathode ray tube (CRT) as the display device implemented shutter-glasses type 3D displays about 20 years ago. Due to the low response speed of the liquid crystal, the refresh rate of a LCD can only get 60Hz. Therefore, this type of 3D display development was hindered for a while. However, the response time of the liquid crystal has been getting faster recently. The refresh rate of an LCD consequently is now as high as 120Hz, even 240Hz in some reported work [17-20]. The four images frame of two viewers can be displayed sequentially on a conventional monitor or projection display. Optical shutter glasses are then used to shut off alternate eyes in synchronization with the display. A synchronization circuit is developed to connect the time scheme of the vertical sync. signal from the display card, the scanning backlight and the shutter glasses [21]. When the viewer looks at the screen through shuttering eyewear, each eye sees only its appropriate perspective view. The left eye sees only the left view, and the right eye only the right view on the screen with 120Hz. Multi-viewer with 3D vision shutter glasses display system is described.

Architecture

Even though the refresh time of an LCD panel is as fast as a CRT display, there are still some problems to be solved before this LCD panel can be implemented

to be a time-multiplexed 3D display, vision and panel seem to be redundant. First of all, LCD is a hold-type display, which is different from the impulse operation type of CRT. This has been a very good property of an LCD while it works at 2D display mode because it can avoid blinking or flickering at the refresh rate higher than 50 or 60 Hz. For a CRT display, viewers will still experience slight image flickering at the refresh rate of about 60Hz. Nevertheless, while working in 3D page-flipping mode and watched through shutter glasses, the hold-type operation causes a problem.

Fig. 1 shows multi-function controlling IC for stereo display. When the left-image begins to fill out the pixels, the left-eye shutter opens immediately. However, at this moment and the following 1/120 sec., the left-image at the upper part of the screen becomes more and more image area of screen, the right-image at the lower part of the screen becomes less and less image area of screen. That means the viewer will see both images at the same time through his right eye. This situation will induce strong double image (or crosstalk) and destroy the 3D perception seriously.

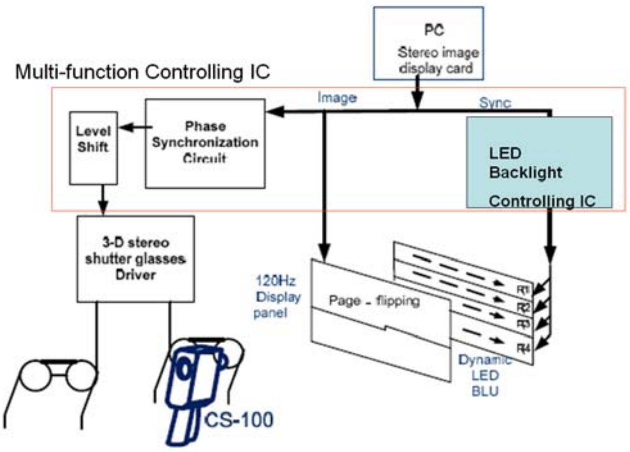


FIG. 1 MULTI-FUNCTION CONTROLLING IC FOR STEREO DISPLAY

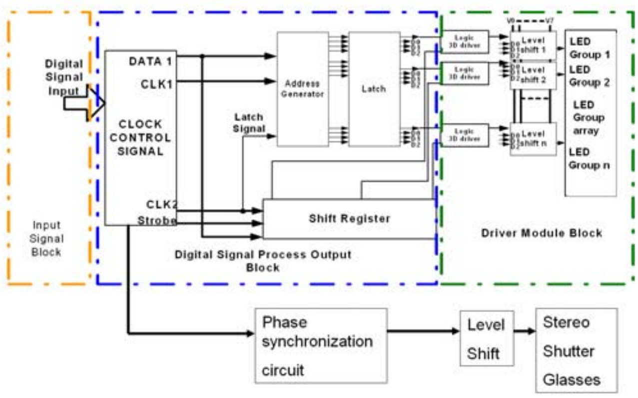


FIG. 2 BLOCK DIAGRAM OF MULTI-FUNCTION CONTROLLING IC ALGORITHM

A smart 3D multiplexed driver for LED switching chip with more than 640 LEDs are proposed and the circuit architecture is shown in Fig. 2.

Dynamic Backlight Signal Process Operation

(1)Scanning backlight method. The setup is as following:

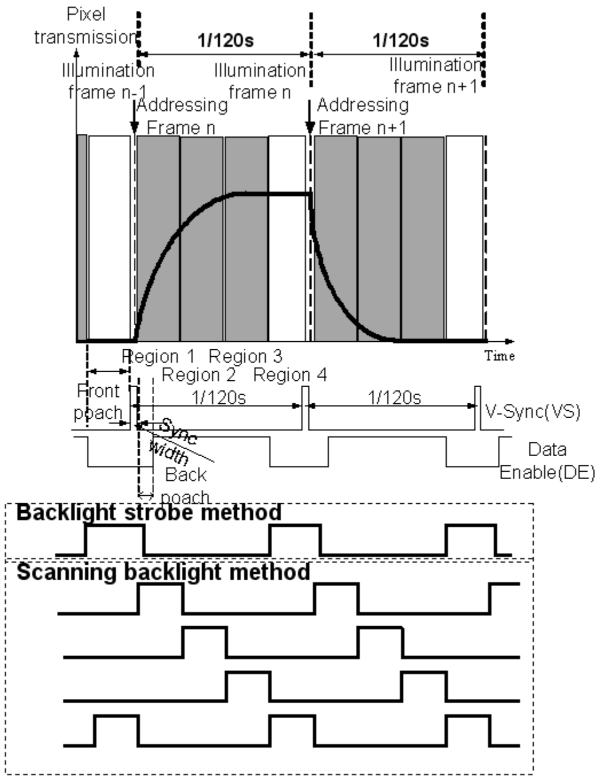


FIG.3 SCHEMATIC DIAGRAM OF BACKLIGHT SIGNAL PROCESSING METHOD

The backlight unit is separated into several regions. Let's take 4 regions as the example as in Fig.3. The pixel response time is less than three fourths of the frame time when the illumination period is one quarter of the frame time. Arranging for the required illumination period to end just before the new image is written into the panel provides the most relaxed requirement for panel response time; i.e., the response time can be longer (Fig. 3). A novel controlled circuit architecture of scanning regions for 120Hz high frequency and high-resolution stereoscopic display is shown in Fig.4. Setup all the parameters of scanning backlight method by counting the amount to decide turning time between 4-regions 、and 2-regions LED backlight type. If counted times equal to 100 then jump to next backlight region (Mean that 100 units of counts during one quarter of the frame time, the illumination period is one quarter of the frame region).

For 4-region scanning backlight method, backlights for regions 1, 2, 3 and 4 will be on when image is filling

the panel regions 2, 3, 4 and 1 by next frame, respectively. I turned on region 3 of the backlight unit in anticipation of an image for a left eye and right eye as shown in the region 1 of the panel (the backlight regions R1 have to be off until R1 filled up the image). Analogize the image shown in region 2 and turned on region 4 of the backlight unit. For 2-region scanning backlight method, when the panel is filled in regions 1 and 2 by the new image, the backlight lights up in the corresponding regions 2 and 1. For avoiding seeing both L-image and R-image at the same time, the backlight regions R1 have to be off until R1 filled up the image. Analogize the backlight regions R2 have to be off until R2 filled up the image.

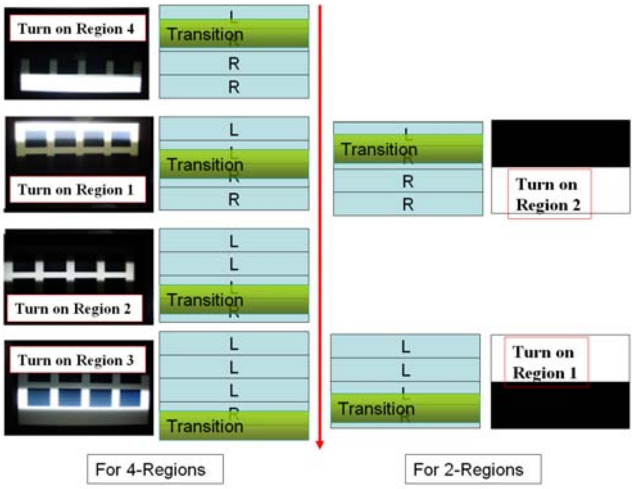


FIG.4 SYNCHRONIZATION SIGNAL LED BACKLIGHT SIGNAL PROCESSING ARCHITECTURE

(2)In backlight strobe method as shown in Fig.3, Setup the parameters of backlight strobe method by counting the amount to decide turning on time of full screen (full screen of one frame 1/120sec counted amount equal to 400). Setup the parameters of backlight strobe duty time by counting the amount to decide turning time on full screen backlight regions. If counted times equal to (400 - 400*9/10) then jump to next full screen backlight region. The backlight is turned off when the image data refreshes. The backlight only turns on at the system time, or at most a little bit longer than the system time. But the system time is short compared with the time between two adjacent vertical synchronization signals (less than 10%), the display brightness operated under this method is probably quite small.

In this paper, it has been successfully designed and demonstrated a decent performance with 120Hz optimized synchronization signal between LED brightness/darkness flash and adjusted shutter glasses signal. It has been demonstrated that the 120Hz scanning characteristic from upper row to lower row of the horizontally arranged of stereoscopic image. A quadrate image for a left eye is projected by the light from the left eye image file and a circle image for a right eye is projected by the light from the right eye file through a liquid crystal panel [22-23].

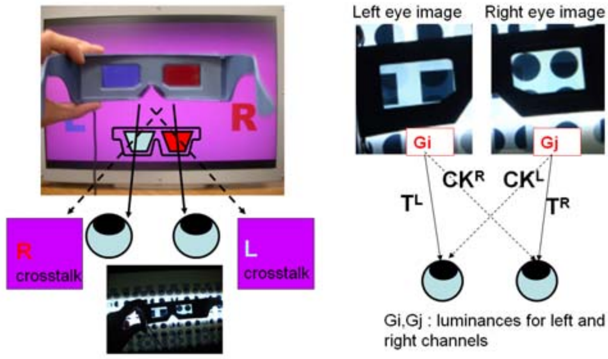


FIG.5 SPECIAL PATTERN WITH EYE SHUTTER (THE CROSSTALK MODEL FOR STEREOSCOPIC DISPLAYS. GI AND GJ ARE THE ORIGINAL SIGNALS FOR LEFT AND RIGHT CHANNELS, RESPECTIVELY).

$$L_{ij} = T^L G_i + CK_{ij}^L G_j \quad (1)$$

$$R_{ij} = T^R G_j + CK_{ij}^R G_i \quad (2)$$

I assume a crosstalk model for stereoscopic displays, illustrated by Fig. 5. This is an extended model. “T” is the fraction of light to the correct channel, and “CK” is the fraction of light that cross over. I keep the transmittance “T” as a constant to prevent the distortion of intended images, but let the crosstalk “CK” dependent on contents (i,j), whose i and j are the gray levels for left and right channels, respectively. Gi and Gj are the corresponding intended luminances for left and right channels, respectively. Gi is measured without glasses, and the display shows the image of corresponding gray level i. Gj is measured as the same way with the image of gray level j. These are the origin signals input into the left and right channels. Hence, the output luminance Lij and Rij for left and right channels can be expressed as follows.

The demonstration pattern from some previous ramblings of mine is quite useful for testing 3D glasses, and by holding the left eye of the shutter glasses to the screen you can see that only the "L" part of the image is let through and “R” part, respectively. As the video card takes care of alternating which set of scanlines (or field) is displayed, the result is that the left and right views alternate perfectly in time with the monitor's refresh rate. It switched between opaque and transparent at a sufficient speed. The above image

displays a test pattern viewed through the glasses. The software alternates between clearing the screen to block(blue) with the left eye shutter open and clearing the screen to white(red) with the right eye shutter open. The colors were deliberately chosen to match the colors of the common anaglyph glasses. As the colors are alternated very quickly, the screen appears a light grey color to the naked eye.

Multi-Viewer Contents

The glasses alternately darken over one eye, and then the other, in synchronization with the refresh rate of the screen, while the display alternately displays different perspectives for each eye, using a technique called alternate-frame sequencing. They are also known as LC shutter glasses or active shutter glasses. The LCD shutter glasses process the signal and control the shutter for each eye to ensure that the correct left and right views are presented to the correct eye. When the viewer looks at the screen content "A" through shuttering eyewear pair "A", the screen content "B" through shuttering eyewear pair "B", each shutter is synchronized to occlude the unwanted image and transmit the wanted image as shown in fig. 6. Thus each eye sees only its appropriate perspective view. The left eye sees only the left view, and the right eye only the right view.

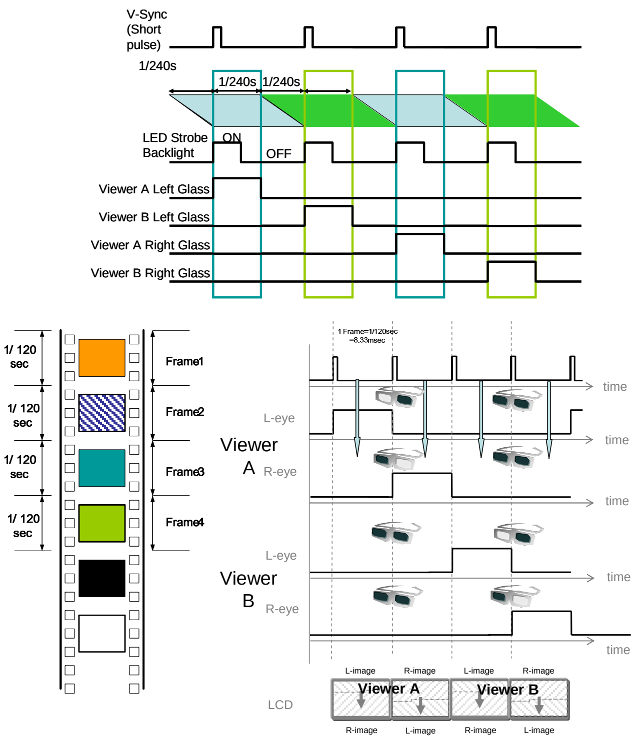


FIG.6 THE CORRECT LEFT AND RIGHT VIEWS ARE PRESENTED TO THE CORRECT EYE WITH SHUTTER GLASSES.

The exact ordering of the states for shutters A left glass through B right glass is actually dependent upon which eye image is drawn in the frame; thus, if one were to draw the images differently in the frame processer, one would need to adjust the timing of the shutters accordingly. This particular configuration was chosen somewhat arbitrarily. As time progresses, the states of the shutters are changed by the controller and the state of each shutter is indicated by the line and a high state indicates that the shutter is clear. A low state indicates that that shutter is opaque. The shutter in front of the panel for person A is clear and the image from the display card will reach the display screen. Also during this time, the shutter in front of person A's left eye shutter is also turned on and the person's left eye will see the image from viewer frame A. In the next instant, the shutter for viewer A is still on so, as you can see, is still high, glass shutter A left is turned off, and the person's left eye can now no longer see the display and the shutter for the person's right eye has been turned on and can now see the display. At this point in time, of course, it is expected that the image from the frame processor which person's right eye should be seeing, is being fed to the display to the screen. In the next instant, the shutters for the viewer A are being turned off and this transition occurs over a small time period and somewhere during this time period the glasses for person A should be completely turned off, A shutters are completely off, as are both left and right eye shutters for person A. In the next instant, the shutters for the glasses A are left off and the shutters for the B person are adjusted. In the first instant, shutter B left is turned on and person B's left eye sees the left eye image.

At the end of this instant the shutter for the person B's left eye is turned off and in the next instant, the glasses for person B will switch over to the right eye so that shutter is on and shutter B left is off. This sequence can be repeated as quickly as it is possible to switch the shutters with reasonable losses.

In order to view any 3D movie using current technologies, you have to separate a left-eye view and a right-eye view into two distinct images that can only be viewed by the corresponding eye. Polarizing technologies are used in most movie theaters to separate the two images that are projected on the screen. LCD shutter technology uses special glasses that alternately apply a voltage to two liquid crystal lenses to darken the left lens while the right is transparent, and then darken the right lens while the

left is transparent. This must happen at a very high rate in order to avoid a strobe effect. Currently, a minimum of a 120 Hz refresh rate is required so that action scenes appear to flow smoothly. The process is referred to as alternate frame sequencing. Thus, the left eye only sees the left-eye image and right eye only sees the right-eye image. Although the refresh rate for the display is 120 times per second, the refresh rate for each lens of the shutter glasses is only 60 times per second. This system is composed of two different video sources, which generally would come from some other type of graphics workstation or personal computer. These are represented by the 120Hz display. These different frames are shown on 1/120secc display for multi-person. This stereo system will display the image from stereo-player on the display. The shutter glasses turn on sequence control circuit is mounted so that the image appears on the display after passing through the shutters. These shutters could be configured as a single panel with strobe backlight.

Experiment

In such a shutter-glasses type stereoscopic display, the display signal (including vertical synchronization, horizontal synchronization and data) is sent from the display card to the LCD panel [24-27]. The switching of the shutter glasses is driven by the vertical synchronization signal from the display card. Due to the possible phase lag between the shutter glasses and the LCD panel, a phase lag circuit is set between these two devices like in Fig.3. The scanning or the strobe of the dynamic backlight is driven by the same vertical synchronization signal.

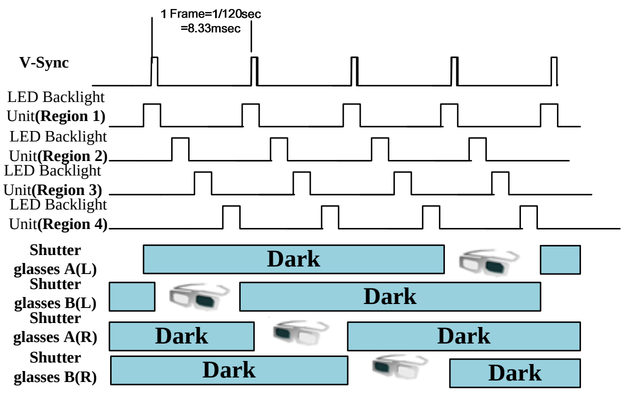


FIG. 7 LED SCANNING BACKLIGHT SIGNAL PROCESSING DUTY CYCLE.

In order to tell which method is better for a shutter-glasses stereoscopic display, three experiments are done. They are 4-region scanning backlight, 2-region scanning backlight and backlight strobe methods. One of the most important properties of the 3D vision display, the crosstalk, is used in these experiments to tell which method is better. The test pattern is in a video stream form, which is like the left diagram in fig.5.

I assume a crosstalk model for stereoscopic displays, illustrated by Fig. 3. The output luminance Lij and Rij for left and right channels are totally Left eye output luminance and totally Right eye output luminance, respectively.

The crosstalk is given by equations (1) and (2):

Totally left eye output luminance
WB=TLW+CKLB, BW=TLB+CKLW,
and BB=TLB+CKLB

Crosstalk of Left eye:

$$C_L = \frac{BW - BB}{WB - BB} = \frac{CK_L(W-B)}{T_L(W-B)} = \frac{CK_L}{T_L} = Crosstalk \tag{3}$$

and
Totally right eye output luminance
WB=TRW+CKRB, BW=TRB+CKRW,
and BB=TRB+CKRB

Crosstalk of Reft eye:

$$C_R = \frac{WB - BB}{BW - BB} = \frac{CK_R(W-B)}{T_R(W-B)} = \frac{CK_R}{T_R} = Crosstalk \tag{4}$$

Where
WB represents a video stream with all white as left-eye images, all black as right-eye images,
BW represents a video stream with all black as left-eye images, all white as right-eye images,
BB represents a video stream with all black for both left and right eyes,
CL and CR represent the crosstalk experienced by the left eye and right eye.

The CS-100 Spot Chroma Meter is used in this paper to measure all the luminance values. The images are displayed in page-flipping mode using the resolution and color-depth set in Stereo/Page-flip Setup as shown in fig.7 and fig.8. Crosstalk of the physical meanings is measured by displaying full black and full-white in opposing eye-channels of the display and using an optical sensor to measure the amount of leakage between channels.

The scanning backlight method turns on several (e.g., 2 or 4) horizontal regions of the backlight in turn, corresponding with the fill-out of the LCD panel. The backlight strobe method is to synchronously apply a control signal to the whole backlight to provide

flashing effect rather than scanning. Both methods can control the brightness of the backlight module by adjusting the duty cycle of the control signal (fig. 3).

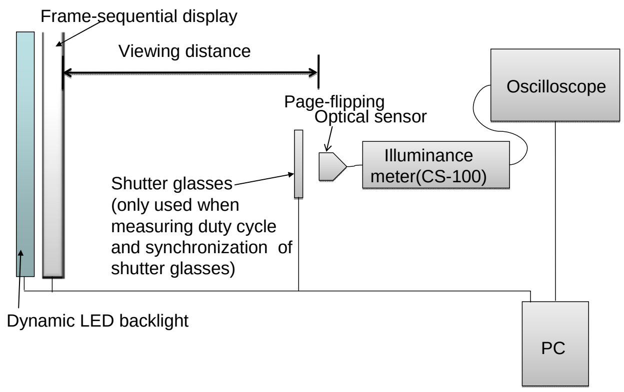


FIG. 8 THE CS-100 MEASUREMENT STEREOSCOPIC DISPLAY SYSTEM

The LCD shutter glasses process the signal and control the shutter for each eye to ensure that the correct left and right views are presented to the correct eye. When the viewer looks at the screen content "A" through shuttering eyewear pair "A", the screen content "B" through shuttering eyewear pair "B", each shutter is synchronized to occlude the unwanted image and transmit the wanted image as shown in fig. 6. Thus each eye sees only its appropriate perspective view. The left eye sees only the left view, and the right eye only the right view.

A stereoscopic image display device is composed of a flat display panel, driver circuits for driving the display panel and an eye shutter to be worn by a viewer. A left eye image and a right eye image are alternately shown on the display panel, and the eye shutter is alternately switched from the left eye to the right eye with 120Hz, in response to display of the respective left and right eye images. Thereby, the displayed image is recognized as a stereoscopic image by a viewer wearing the eye shutter.

Because shutter glasses require a screen refresh rate twice that of a normal display, extremely high performance graphics technology is required to support it. Most inexpensive products advertised as being shutter-glasses compatible are only capable of 120Hz refresh, equivalent to the industry minimum of 60 frames per second.

The technologies, which are originally developed mainly in mainframe computers as a core part of the "virtual reality" environment, are growing very rapidly with popularity gained in the personal computer domain as well. You need to wear a pair of 3D shutter glasses to visualize the 3D pictures and 3D videos given below. With the signal (via electrical wire or infra-red) emitted from the computer which is synchronized with the images/videos displayed on the computer monitor, the right-hand and left-hand shutter glasses will turn on and off sequentially to let the observer view the right-hand and left-hand images of the objects or videos. As the refresh rate is fairly high (>60 frames per second), our human brain will treat the images from the two eyes to arrive simultaneously and combine them to form the 3D images, which have the depth clues.

Results and discussion

Fig. 9 shows the image of a fabricated 32 _ 20 matrix LED sets controller module. In this module, the chip area of 2.5 _ 2.5 mm and was fabricated by a two-poly four-metal (2P4 M) 0.35 um twin-well CMOS technology (TSMC, Taiwan Semiconductor Manufacturing Company Ltd). Each transistor is surrounded by full guard ring for preventing electrostatic shock. The testing result of the IC demonstrated the scanning of 640 LEDs switches takes 60.5 ls for two dimensional circuit architect while 20.5 ls for the 3D one, representing a time saving of 40 us or a 67% time reduction.

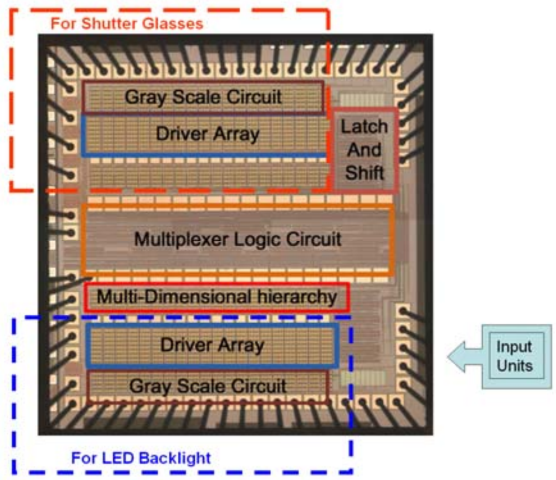


FIG. 9 PHOTOGRAPH OF FABRICATED CONTROL IC CHIP.

There is a phase difference between the vertical synchronization signal and the shutter glasses switching time. A phase lag circuit is applied to correct the difference. The synchronized shutter glasses can be used to separate the left-eye image and the right-eye image. However, even the block and transparent function of the shutter glasses is perfect, if the synchronization is not exact, or the response time of the liquid crystal is not fast enough to operate with 100 to 120 Hz, the viewer will still experience serious crosstalk. Therefore, reduction of the crosstalk is very

important while making a stereoscopic display.

The luminance of the 3D LCD is measured and recorded as WB, BW and BB charts. They are shown in fig.7. The measurement distance is 1 meter and the recording unit is "nit". The crosstalk is calculated by the equations 3 and 4. As a result, the luminance of a 4R scanning backlight display for one viewing zone is 28.825 nits, that of a 2R scanning backlight display for one viewing zone is 57.25 nits, and that of backlight strobe display is 28.45 nits.

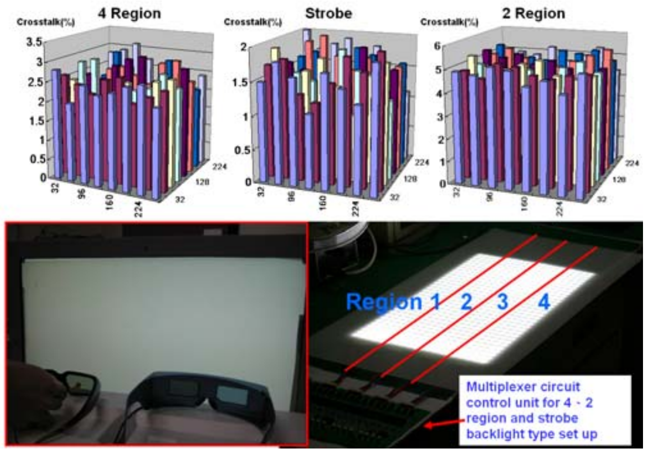


FIG. 10 OPTICAL SENSOR AND CS-100 SPOT CHROMA METER OF LUMINANCE CROSSTALK MEASUREMENT OF THE 4-REGIONS、2-REGIONS SCANNING AND STROBE BACKLIGHT METHOD

Fig.10 Optical sensor and CS-100 Spot Chroma Meter of luminance crosstalk measurement of the 4-regions 、2-regions scanning and strobe backlight method. The numbers in x and y axes are show the gray level(28，0~255 gray level) of the panel. I proposed an extended crosstalk model and measured the crosstalk to vary from the displayed gray levels(0~255 gray level), and showed a rigorous calculation of crosstalk.

The crosstalk under different scanning conditions is calculated from data in fig.10, including the cases of 4-Region and 2-Region scanning backlight method, and backlight strobe method (1 Region). The crosstalk of 4R and 2R scanning backlight displays are 3.2% and 5.08% respectively, and that of backlight strobe display is 1.68%.

According to the results of fig.10 and 11, the brightness of the 4R scanning backlight and the widened backlight strobe is about half of the 2R scanning backlight. But the crosstalk performance of the widened backlight strobe crosstalk is the best of three methods. It is about 1.68%. Although the 4R scanning backlight display crosstalk is higher than widened backlight strobe, it still performs better than the 2R scanning backlight one. The crosstalk of conventional backlight LCD auto-stereoscopic display is beyond 10%. Woods' paper introduces a crosstalk model, which incorporates phosphor afterglow and shutter leakage. Past studies by the authors have also examined the sources of crosstalk in time-sequential 3D displays [28-29].

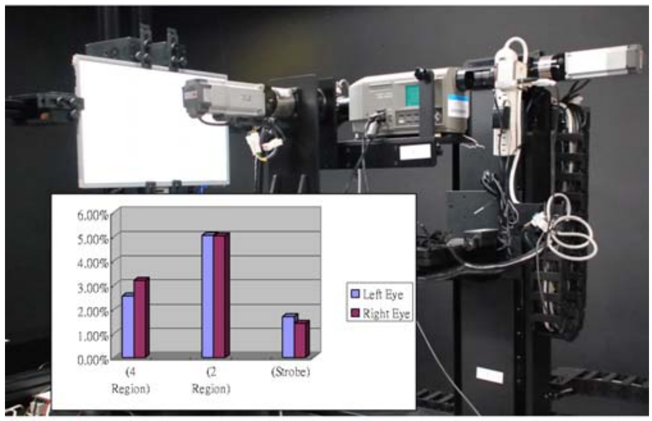


FIG. 11 RESULTS OF CROSSTALK CALCULATION OF DIFFERENT DYNAMIC BACKLIGHT METHODS

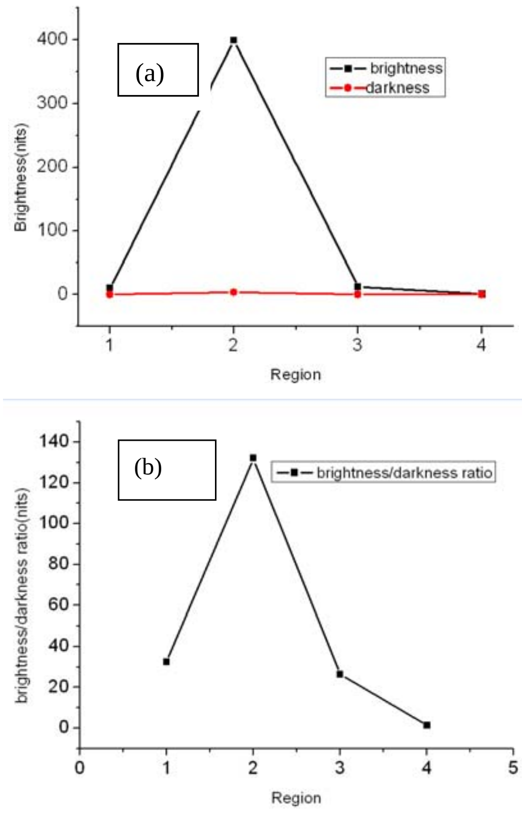


FIG.12 (a) AVERAGE BRIGHTNESS OF DISPLAY (b) BRIGHTNESS/DARKNESS OF DISPLAY

Fig.12(a). shown the average brightness of display. Fig. 12(b). shown Brightness/darkness of display. It is high Brightness/darkness of display. The CS-100 Spot

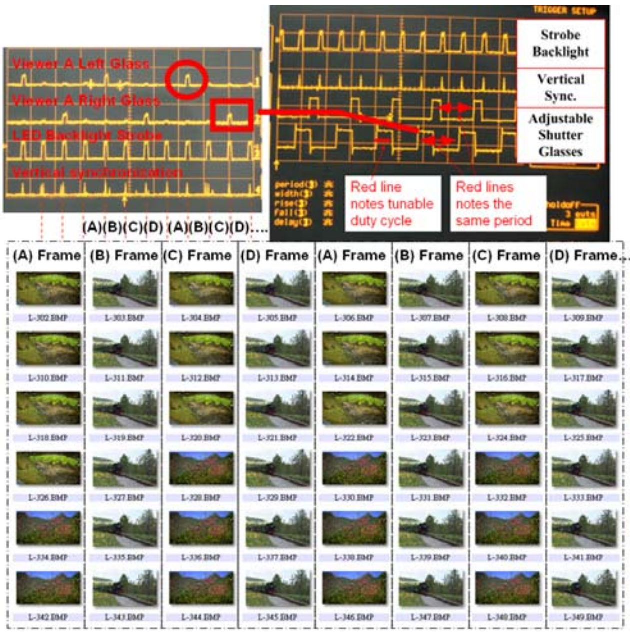
Chroma Meter can measure all types of light sources including LED's set of turned on region. The CS-100 is highly accurate, completely portable and has a fast measurement time. I have measured brightness/darkness ratio and shown in fig. 12(b). The measurement distance of 1m by three times and the units is “nits”, it demonstrated high brightness/darkness ratio on Region 2, and then reduce the cross-talk image shown in fig. 8 between the left and right eye through the shutter glasses.

Frame is interfaced to display screen whose image passes through shutter glasses on its way to display. The LCD are running at a vertical frequency and displaying alternate frames of left and right eye imagery. The viewer A looking through glasses will only be able to see the image from viewer frame A and the person using shutter glasses will only be able to see the image from LCD screen. In practice, there will be some bleed-through of both the glasses and the shutters so that the images seen by each person will also include some slight visual "shadows" where the other image is being displayed. This may be improved by improving the contrast ratio of the various optical shutters and by improving the off-axis performance of the various shutters and the performance of the display systems.

Viewer A Left eye frame content	Viewer B Left eye frame content	Viewer A Right eye frame content	Viewer B Right eye frame content
			

FIG. 13 MULTI-VIEWER CONTENTS FULL RESOLUTIONS 3D SHUTTER GLASSES DISPLAY SYSTEM.

This interface allows the personal to control the shutters for viewer frame A, which are driven by driver. The images from viewer frame B also pass through B shutters. These shutters are controlled by the synchronization circuit through the sync signal interface and driver. In operation, the shutters for viewer frame A and viewer frame B are driven at a fast rate so that the images coming from the display card are simultaneously displayed of view. The shutters in front of LCD screen are turning on and off very quickly (>100 Hz) in order to modulate the light coming from the LED backlight as shown in fig.13. They are modulating the light in strobe type, the backlight is turned off when the image data refreshes. The backlight only turns on at the system time as shown in fig.11. But the system time is short compared with the total frame refresh time (or the time between the two vertical synchronization signals, which is less than 10%).



(A) Frame of Viewer A Left eye content images,
(B) Frame of Viewer B Left eye content images,
(C) Frame of Viewer A Right eye content images,
(D) Frame of Viewer B Right eye content images.

FIG. 14 THE VARIOUS STATES OF THE SHUTTERS WAVEFORM WITH V-SYNC AND VIEWER A、B CONTENT IMAGES.

The sync signal from each of the frame processer is fed to a display card, which provides the vertical synchronization signals relative to the top of the picture by counting A sync. and B sync. as required. In this system, the synchronization circuit controls the state of the various shutters through adjustment wide or narrow pulse for corresponding viewer frame as shown in fig. 14.

Fig.14. shows the various states of the shutters in the system. The first cycle of the sequence is for person A to see the left and right eye images, which are appropriate. Following this, the second person, person B, sees the left and right eye images from their respective frames of view. This is accomplished in the

following manner. Time in the figures run from left to right. In this figure, time "starts" at the transition from opaque to clear of the shutters in front of viewer frame A. Time in the figure runs to the right and the state of the various shutters is indicated by the line to the right of the name of the shutter and the following shutters are shown: shutter A waveform indicates the shutters that are located in front of the screen corresponding to person A. Shutter B waveform is representative of the shutters which are positioned in front of the screen corresponding to person B. Shutter A left glass represents the state of the shutters in front of the person A over their left eye. Shutter A right glass is for the shutter over person A's right eye. Shutter B left glass is over person B's left eye, and shutter B right glass is over person B's right eye.

Conclusion

Several backlight methods of shutter-glasses type stereoscopic displays have been measured to analyze differences of their 3D vision performance. The less the backlight regions are, the brighter the display with scanning backlight method is. Therefore, a 2R scanning backlight is brighter than a 4R one. Nevertheless, due to better separation of a 4R scanning backlight, the crosstalk of it is less than that of a 2R scanning backlight. However, from the other aspect, the uniformity of a scanning backlight method is usually not as good as than backlight strobe method. When display comes to 3D TVs, Screen brightness does have an important role to play because of the use of 3D glasses to view the 3D content. Active Shutter glasses cause a net loss in light transmission thus dimming the image that is perceived by our eyes. With newer LED backlight technology, LCD TVs have improved even further when it comes to the backlight brightness of the television displays.

In this article, I have successfully designed and demonstrated a multi-function controlling IC for multi-viewer contents full resolutions 3D vision shutter glasses display, I employed the different viewer looks at the screen of different content through shuttering eyewear pair with strobe LED backlight display, each shutter is synchronized to block the unwanted image and transmit the wanted image. They created a clear picture, especially when the computer is set at a high refresh rate.

REFERENCES

P. J. Bos, K. Roehler/Beran “The pi-cell: a fast liquid-crystal optical-switching device” Mol. Cryst. Liq. Cryst., 113, 329-339,(1984).

P. Bos, “Stereoscopic imaging system with passive viewing apparatus”, US Patent 4,719,507,(1988).

L.Lipton, J.Halnon, J.Wuopio, B. Dorworth “Eliminating pi-cells artifacts”, Sterescopic Displays and Virtual Reality Systems VII, Vol. 3295, 264-270, (2000).

C. vanBerkel and J.A. Clarke “Characterisation and Optimisation of 3D-LCD Module Design” Proc SPIE Vol. 3012, (1997).

Okui, M., Okano, F., Yuyama, I., “A study on scanning methods for a field-sequential stereoscopic display”, IEEE Transactions on Circuits and Systems for Video Technology, Volume: 10 Issue:2 ,page(s): 244 – 253(2000).

J.-H. Park, K. Hong, and B. Lee, "Recent progress in three-dimensional information processing based on integral imaging," Applied Optics, vol. 48, no. 34, pp. H77-H94, 2009.

S. Pastoor and M. Wopking 3-D displays: a review of current technologies. Displays 17, (1997).

L. Lipton Synthagram: autostereoscopic display technology. Proceedings of the SPIE, Vol. 4660, (2002).

Tatiana Sergan; Vassili Sergan; Boyd MacNaughton,” High-Performance Active Liquid Crystalline Shutters for Stereo Computer Graphics and Other 3-D Technologies”, Journal of Display Technology, Vol 3 , Issue: 1, Page(s): 29 – 35,(2007).

P. Bos, “Liquid crystal shutter systems for time-multiplexed stereoscopic displays” , Stereo Computer Graphics and Other True 3D Technologies, D. F.McAllister, Ed. Princeton, NJ: Princeton University Press, pp. 101–103,(1993).

S.S. Kim, K.H. Cha, J.H. Sung,” 3-D Display” SID’02 Digest, pp.1422,(2002).

Daejin Park, Tag Gon Kim , Changmin Kim, Sungho Kwak ,”A Sync Processor with Noise Robustness for 3DTV Active Shutter Glasses”, International SoC Design Conference (ISOCC), pp.147-149(2010).

JA Roese, “Stereoscopic electro-optic shutter CRT displays—a basic approach,” in Processing and Display of Three-Dimensional Data II, J. J. Pearson, ed., Proc. SPIE 507, 102–107 (1984).

Bohm, J. Frank, and L. Joulain, “An LCD helmet mounted

display with stereoscopic view for helicopter flight guidance," in Helmet- and Head-Mounted Displays V, R. Lewandowski, L. Haworth, and H. Girolamo, Eds., Proc. SPIE 4021, 66–78 (2000).

Srivastava, A. K., de Bougrenet de la Tocnaye, J. L., Dupont, L., "Liquid Crystal Active Glasses for 3D Cinema", Journal of Display Technology, Vol. 6, No. 10, Page(s): 1 - 9, OCTOBER 2010.

Strategic Semicond. Dev. Center, Panasonic Corp., Moriguchi, Japan, "Three-dimensional imaging technology: A revolution in the world of imaging", IEEE Symposium on VLSI Circuits (VLSIC),pp.9-12(June 2010).

Sang Soo Kim*, Bong Hyun You, Heejin Choi, Brian H. Berkeley*, Dong Gyu Kim, and Nam Deog Kim," World's First 240Hz TFT-LCD Technology for Full-HD LCD-TV and Its Application to 3D Display", SID 09 DIGEST,pp.424-427,(2009).

S. S. Kim, B. H. You, J. H. Cho, D. G. Kim, B. H. Berkeley,and N. D. Kim, "An 82-in. ultra-definition 120-Hz LCD TV using new driving scheme and advanced Super PVA technology", Journal of the SID 17/2, p. 71-78 (2009).

S. S. Kim, B. H. You, N. D. Kim, and B. H. Berkeley, "Novel 120-Hz TFT-LCD motion-blur-reduction technology with integrated motion-compensated frame-interpolation timing controller", Journal of the SID 16/3, p. 403-413 (2008).

S. S. Kim, B. H. Berkeley, and T. S. Kim, "Advancements for highest performance LCD-TV", SID Symposium Digest Tech. Papers 37, p. 1938-1941 (2006).

Woods, A.J., "Compatibility of Display Products with Stereoscopic Display Methods", in Proceedings of the International Display Manufacturing Conference 2005 (IDMC'05), ISBN 957-28522-2-1, Taipei, Taiwan, 22-24 February (2005).

Jian-Chiun Liou, Kuen Lee, "Shutter Glasses Stereo LCD with a Dynamic Backlight", Proceedings of SPIE-IS&T Electronic Imaging, SPIE Vol. 7237 72370X-1–72370X-8(2009).

Jian-Chiun Liou, Jui-Feng Huang, Kuen Lee, "Synchronization Signal Circuit System for Low Cross-talk Stereoscopic Display", IMID/IDMC/ASIA Display, pp. 1405–1408(2008).

K. Taira, G. Hamagishi, K. Izumi, S. Uehara, T. Nomura, K.Mashitani, A. Miyazawa, T. Koike, A. Yuuki, T. Horikoshi,Y. Hisatake, H. Ujike, Y. Nakano, "Variation of Autostereoscopic Displays and Their Measurement",IDW'08 Proc., pp.1103-1106, (2008).

S. Uehara, K. Taira, G. Hamagishi, K. Izumi, T. Nomura, K.Mashitani, A. Miyazawa, T. Koike, A. Yuuki, T. Horikoshi, Y. Hisatake, H. Ujike, "Methodology of Optical Mesurement for Autostereoscopic Displays", IDW'08 Proc., pp.1107-1110, (2008).

A. Yuuki, S. Uehara, K. Taira, G. Hamagishi, K. Izumi, T. Nomura, K. Mashitani, A. Miyazawa, T. Koike, T. Horikoshi, H. Ujike, "Viewing Zones of Autostereoscopic Displays and their Measurement Methods", IDW'08 Proc., pp.1111-1114, (2008).

T. Koike, A. Yuuki, S. Uehara, K. Taira, G. Hamagishi, K. Izumi, T. Nomura, K. Mashitani, A. Miyazawa, T. Horikoshi, H. Ujike, "Measurement of Multi-view and Integral Photography Displays Based on Sampling in Ray Space",IDW'08 Proc., pp.1115-1118, (2008).

Woods, A.J., Yuen, K.-L. (2006) "Compatibility of LCD Monitors with Frame-Sequential Stereoscopic 3D Visualisation" (Invited Paper), in IMID/IDMC '06 Digest, (The 6th International Meeting on Information Display, and The 5th International Display Manufacturing Conference), pg 98-102, Daegu, South Korea, 22-25 August 2006.

Woods, A.J, and Sehic, A. (2009) "The compatibility of LCD TVs with time-sequential stereoscopic 3D visualization" in Stereoscopic Displays and Applications XX, Proceedings of Electronic Imaging, Proc SPIE Vol.7237, San Jose, California, 19-21 January 2009.

Jian-Chiun Liou received his PhD in Nano Engineering and Micro Systems Institute of National Tsing Hua University, Taiwan, in 2009.

His research interests are in the fields of Integrated Circuit design, Optoelectronics, Display, ASIC design, VLSI Engineering, optical MEMS technology, integration of inkjet printhead processes and display technology.

He joined the Printing Technology Development and Manufacturing Section, Optoelectronics and Systems Laboratories, Industrial Technology Research Institute (ITRI), Hsinchu, in 1999, where he focused on ink-jet printing system. Since 2005, I have been a Project Leader working on a new MEMS architecture design and display application in the Electronics and Optoelectronics Research

Laboratories,

ITRI. His research interests are in the fields of ASIC design, optical MEMS technology, integration of ink-jet printhead processes, and display technology. I am the holder of 33 patents on ink-jet printheads and has written more than 20 SCI Journal papers and 32 conference technical papers on MEMS, optical-N/MEMS, and display-related fields, micro-/nanofluidics related fields, and co-chaired many conference technical sessions and invited speaker. Advance project leader(ITRI), SCI Journal paper reviewer(Optics Express、PIER、JEMWA、MEE), Research fellow(NTHU). He is the recipient of honors :ITRI/OES Research Achievement Award (2004), ITRI Research Paper Publicated Award (2004), ITRI/EOL Research Achievement Award (Individual person Award, 2005),ITRI/EOL Outstanding Advanced Research Silver Award (2005),ITRI/EOL Research Achievement Award (2006),ITRI/EOL Patents Reviewer(2007), Outstanding Research Award (2007), ITRI/EOL Patents Reviewer(2008), Outstanding Research Award (2010), ITRI/EOL Patents Reviewer(2009), SCI Journal paper reviewer, ITRI/EOL Outstanding Research Award (2010), International R&D 100 Awards (2010), 1st International Contest of Applications in Nano-Micro Technology Award (2010)—OPTO- MEMS Device Application. I am a member of the (SID)Journal, and a reviewer for more than 20 international journals including Integrated circuit, Applied Physics Letters, Microfluidics and Nanofluidics, and Microdevices. I have also been a consultant to three Taiwan companies